ous changes, and polypoid lesions are easily seen in under ten minutes. If more serious conditions are suggested, the patient can have an elective complete CT sinus study, but limited CT is more useful and no more costly than plain films.

Normal appendices are found in 15% to 25% of appendectomies for suspected acute appendicitis. Although deaths are rare, the morbidity and cost of negative laparotomy are substantial. Those in whom improved preoperative diagnosis is of particular value include women of reproductive age, where the normal appendix rate is 35% to 45%; pregnant patients where abortion is a consideration; very young, older, immunosuppressed, and other patients with atypical presentations.

Graded compression sonography, combined with transabdominal or transvaginal ultrasound, can visualize an abnormal appendix directly and show an alternative pathologic process, particularly gynecologic disease. In this study, the operator uses the transducer to gradually compress the abdomen at the site of pain, while searching for a dilated, thick-walled appendix, abnormal fluid collection, or appendicolith. Accuracies of 80% to 90% have been reported, but the method is operator dependent, and sensitivity is reduced if the appendix has perforated. Computed tomography may also show an abnormal appendix and is particularly useful in the 5% of patients who present with right lower quadrant mass, often distinguishing between phlegmon and abscess and helping with percutaneous drainage of the latter.

Patients with acute osteomyelitis usually do not have findings on plain radiographs seven to ten days after the onset of symptoms. Nuclear medicine technetium 99m (^{99m}Tc)-MDP bone scans are 95% sensitive but are not specific. A negative study result 24 hours after the onset of symptoms, however, essentially rules out acute bone infection. The three-phase bone scan improves specificity, often differentiating osteomyelitis from cellulitis, a common problem in the feet of diabetic patients. Specificity is further increased by the use of indium 111-labeled oxine or ^{99m}Tc-HMPAO leukocyte scans in conjunction with bone scans, but these scans take 24 hours to complete.

Magnetic resonance imaging (MRI) is as sensitive as and more specific than ^{99m}Tc-labeled medronate disodium bone scintigraphy, showing marrow as well as soft-tissue and periosteal changes. It can be done in less than two hours, but it is costly, not universally available, and, like bone scans, can occasionally result in false-positive results, particularly in the setting of trauma, previous surgical procedures, or neuropathic joint disease. In suspected vertebral osteomyelitis, however, MRI is the method of choice. Multiplanar imaging capabilities facilitate the depiction by MRI of vertebral body marrow alterations, disc involvement, and paraspinal or epidural abscess with unsurpassed clarity.

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Picture Archiving and Communication Systems

WITH THE INTRODUCTION of computed tomography (CT) and magnetic resonance imaging (MRI), an ever-increasing proportion of procedures done in radiology are acquired in a digital format. In addition, computed radiography (CR), which uses phosphostimulable plates instead of film, may replace conventional radiography, especially for portable examinations of the chest.

Picture archiving and communication systems (PACS) acquire, transmit, store, and display image information. Besides acquiring images directly from digital modalities (CT, MRI, and nuclear medicine) and from CR, these systems use laser digitizers to convert images on radiographic film to digital images. The images stored in PACS can be reproduced either on film with a laser camera or displayed using a high-resolution television monitor. Picture archiving and communication systems are expected eventually to replace most radiographic film. Reducing the operating costs associated with handling and storing radiographs and eliminating film and film processing may make these systems cost-effective in spite of the initial large expenditures for equipment.

When images are in digital form, they can be manipulated or processed by using window and level controls (intensity and contrast), inverse intensity (white on black to black on white), or edge-enhancement (unsharp masking). For a particular patient, images from the various modalities or from previous studies can be placed on the same or associated monitors for comparison. Such systems obviously would speed the retrieval and display of images. Treatment can be initiated earlier for patients in an Intensive Care Unit when digital images are readily available. The frequency of communication between the radiologist and the referring physician may decline, however, because in some instances the images are being viewed before the radiologist's interpretation is received.

The spatial and contrast resolution of the current digital modalities can be faithfully reproduced with PACS, especially if film is used for the primary interpretation. Although most investigators would agree that soft-copy display is also more than adequate, there still are concerns about the contrast gray levels that can be seen without varying the window and level on these displays. The simultaneous display of a large number of images is difficult. Also, subtle bone abnormalities, microcalcifications in mammography, and perhaps pneumothoraces are still somewhat difficult to see on these displays.

To date, only a handful of large institutions have successfully implemented clinical PACS. The reasons for the slow introduction of this technology are multiple, but two issues are clearly paramount: capital expense and resolution limitations. In one study examining the cost of PACS, the potential for substantial reductions in operating costs to offset capital depreciation was shown. This study, however, did not include a commercial manufacturer's cost for research and development, liability insurance, or a profit margin. Almost all of the savings that can be realized with PACS are related to the current digital modalities with little, if any, savings to be accrued on the general radiographic side (CR or digitizing radiographs).

In addition to the possible reduction in operating costs and improved efficiency in the handling of medical images, PACS could enhance medical education by providing sophisticated retrieval capability from the image database based on radiologic or pathologic findings.

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Shoulder Magnetic Resonance Imaging

THE STRENGTH AND STABILITY of the most mobile but least stable joint in the body, the glenohumeral joint, is provided by the four muscles of the rotator cuff. The supraspinatus, infraspinatus, teres minor, and subscapularis muscles form a musculotendinous cuff that envelopes the humeral head and glenohumeral joint. The supraspinatus muscle is interposed between the humeral head and coracoacromial arch.

The impingement syndrome is a common cause of shoulder pain and may cause 95% of rotator cuff tears. When the soft tissue structures of the rotator cuff become entrapped between the coracoacromial arch and the greater tuberosity of the proximal humerus during abduction and elevation of the arm, a series of pathologic events may occur. Subacromial bursitis and rotator cuff tendinitis occur first with progression to fibrosis and rupture of the rotator cuff later. The impingement may occur at the site of the anterior acromion, at the acromioclavicular joint due to spurring, or along the undersurface of the coracoacromial ligament.

Most rotator cuff tears affect the supraspinatus tendon 1 cm proximal to its site of insertion, the "critical zone," near its attachment to the humeral tuberosity. Anterior and posterior extensions may occur, but less frequently. Complete tears are defined as full thickness tears of the rotator cuff. Partial tears are incomplete tears that do not allow fluid to flow between the glenohumeral joint and the subacromial bursa.

The signs and symptoms of rotator cuff tears are not specific. Consequently, the diagnosis is often delayed until a complete tear has occurred. The goal of evaluating shoulder pain should be to determine the cause before irreversible tendon damage has occurred.

Magnetic resonance imaging (MRI) provides excellent depiction of the anatomic structures of the shoulder, including the rotator cuff, the long head of the biceps tendon, articular capsule, muscles, and bone. The improved contrast and additional imaging planes of MRI provide the orthopedic surgeon with anatomic information regarding the presence of tendinitis versus a partial tear versus a complete tear of the rotator cuff. This information, in addition to the clinical presentation, assists the surgeon in determining treatment, that is, physical therapy, arthroscopy, or an open surgical procedure.

The MRI findings of tendinitis are thickening of the cuff tendon and intermediate (grey) signal replacing the normal low signal (black) tendon. Partial tears show a focal thinning of the tendon and may have fluid within the niche. With complete rotator cuff tears, the normal low-intensity signal of the tendons is interrupted by a bright signal indicating discontinuity of the rotator cuff. The (high signal) discontinuity may be filled by either fluid, granulation tissue, or hypertrophied synovium.

Compared with arthroscopy, MRI showed a sensitivity of 100% and specificity of 88% in evaluating rotator cuff tears and a sensitivity of 92% and a specificity of 100% compared to a surgical procedure. Magnetic resonance imaging is able to show bony impingement on the rotator cuff tendon and can indicate other causes of shoulder pain, including effusions, occult fractures, metastases, avascular necrosis, labral tears, and loose bodies. Magnetic resonance gadolinium arthrography may be indicated in cases of dynamic instability, failed surgical procedures for rotator cuff tears, negative noncontrast MRI, and in differentiating partial tears from tendinitis.

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The Imaging of Impotence

IMPOTENCE AFFECTS more than 10 million men in the United States. Clinical evaluation usually can exclude endocrinologic imbalance, neurogenic dysfunction, and psychologic problems as etiology. A patient who fails to get an erection after vasoactive medications are injected probably has hemodynamic impotence. Dynamic studies that include imaging techniques are now available to discriminate between arterial and venous pathology.

Doppler ultrasound with color flow and spectral analysis, dynamic infusion corpus cavernosometry and cavernosography, and selective internal pudendal arteriography are outpatient diagnostic procedures that will differentiate, image, and quantify the abnormalities in patients with hemodynamic impotence. Not all tests are needed in every patient. Each of these examinations is preceded with the intracavernosal injection of vasoactive medication. Papaverine hydrochloride, phentolamine mesylate, or prostaglandin E_1 will overcome normal sympathetic tone and produce an erection by smooth muscle relaxation and arterial dilatation in a normal patient.

Color-flow Doppler and spectral analysis will show the cavernosal arteries and can identify the hemodynamic effects of stricture or occlusion. Peak systolic velocity is measured. Normal ranges are well established. Spectral analysis also is used to predict the presence of venous disease. Sizable venous leaks in the dorsal penile vein are readily imaged. While the technique may not adequately identify low-grade venous pathology, it will identify the size and location of fibrous plaque formation associated with Peyronie's disease.

Cavernosography or cavernosometry is a separate procedure that will quantitate the severity of venous incompetence as well as specifically identify the various avenues of systemic venous return that must be localized if venous occlusive therapy is chosen. In this study, the peak arterial systolic occlusion pressure is quantified during erection, and the presence of arterial pathology can be confirmed. The arterial data are not as reliable as the ultrasound-obtained data because they rely on audible Doppler, which can be obscured in the underlying "noise" heard with erection. The arterial data obtained with both of these examinations are quantitative and replace the qualitative audible Doppler used previously. Specialized equipment (Life Tech, Houston, Texas) allows dy-